



Gamification of the Laboratory Experience to Encourage Student Engagement †

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INTRODUCTION

The American Society for Microbiology (ASM) Task Force on Curriculum Guidelines for Undergraduate Microbiology Students published recommendations for introductory microbiology courses that suggest teaching specific skill sets in the laboratory beyond just fundamental knowledge and concepts of microbiology (6); however, students can sometimes view a skills-based laboratory experience as a task list of unrelated assignments to complete for a grade. Therefore, providing explicit connections throughout the lecture and laboratory exercises is critical for a truly integrated learning experience.

Several pedagogical techniques can provide a coherent framework throughout a course. For example, case-based studies can connect lecture with laboratory skills and increase student engagement by applying newly developed knowledge and skills to tackle real-world simulations (2, 3). One reason that case-based studies succeed is that they can provide intrinsic motivations and an alternate purpose for students to engage with the material. A more recent trend in pedagogy involves using game design elements to increase student engagement and motivation. Gamification is the application of game design (accruing points or badges, reaching significant levels of accomplishment, or other reward elements) in a non-game context to motivate or influence participation (1, 5). A natural extension of both of these methods is to gamify a case-based approach where a fictional scenario is presented for students to role-play as scientists using their developed skills to solve a complex problem.

The typical microbiology laboratory, as described by the ASM Task Force, can easily incorporate game design elements without extensive modification of the exercises themselves. Instead, gamification involves structuring the lab in a way that gives the course a coherent and unified purpose. This ultimately allows the student to see how the

principles and concepts of lecture and laboratory connect to real world situations.

PROCEDURE

Gamification of the laboratory experience was implemented during the same semester for two upper-level, general microbiology laboratory sections of approximately 20 students. Sections met twice a week for two hours each session. Each student was required to obtain *Techniques in Microbiology: A Student Handbook* for reference and a generic laboratory notebook for writing up protocols, experiments, and observations (4). The laboratory curriculum was designed to follow guidelines for laboratory skills recommended by ASM (6). In general, these guidelines advocate student competency in laboratory safety, aseptic technique, microscopic and macroscopic observation, culture methods and isolation techniques, identification of microorganisms, use of appropriate microbiological equipment, and documentation of laboratory methods and observations.

Game design and assessment

The entire laboratory component was contained within the framework of the fictional game: *Micropocalypse* (Appendix 1). This game takes advantage of the current cultural popularity of zombies and end-of-the-world scenarios. The basic premise was that an unknown pathogen destroyed much of society and the Centers for Disease Control and Prevention (CDC) needed help to identify and destroy the unknown pathogen and then to reestablish society. These tasks were accomplished by teams of students playing the role of CDC scientists who use their training in basic laboratory skills to confront the *Micropocalypse*. At the beginning of each week, students received instructions for the laboratory exercises from the fictional and mysterious character, Dr. X. Along with his weekly instructions, other important details such as which strains to use, what type of data to expect, and how to document and record observations were given to the students (Appendix 2).

Completed laboratory notebooks, success in two laboratory practicals, and two formal reports (identifying an unknown and presenting their resolution to the game) were used to assess student knowledge and skills. As students

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gained experience and laboratory skills, they “leveled-up” in the game from “Student” to “Senior Scientist.” Each level was skill-based and students were allowed to repeatedly demonstrate their abilities until they became proficient enough to move on to the next level. Students reached each of the five levels in the game as part of the course, moving on to the next set of skill sets and experiences throughout the semester (Appendix 1).

Implementing laboratory exercises as game objectives

The game was divided into three phases. The first phase of the game was a training program where students learned the basic techniques and skills of microbiology including microscopy, staining techniques, isolation protocols and aseptic techniques, and how to use media and biochemical tests to identify microorganisms. During the second phase of the game, each laboratory group was given a fictional causative agent of the Micropocalypse and used the skills developed in the training phase to identify their unknown bacteria. Each group received a different species. The next objective in the game was to use the Kirby-Bauer disk diffusion technique to find antibiotics with the potential to eradicate the pathogen they identified. The final phase of the game focused on applied microbiology skills where students developed protocols to treat and purify water, make fermented foods, and produce energy with a microbial fuel cell.

Throughout the semester, students received parts of the background story related to the Micropocalypse (Appendix 3). While this component is optional, students enjoyed playing along in this fictional world. Hints about the cause of the Micropocalypse were given to students in the form of DNA that had to be translated into a peptide code spelling out simple clues to solve the mystery. Students presented a final report of their progress throughout the semester and how they intended to creatively resolve the game (Appendix 4).

Safety issues

All laboratory exercises were conducted in a Biosafety Level 2 facility and followed appropriate protocols for the safe handling of bacterial strains and chemicals. Instructors are encouraged to consider additional safety issues specific to their own laboratory as they modify this activity.

CONCLUSION

Student response to the game format was overwhelmingly positive. Anonymous student perception surveys revealed that students felt engaged and interested in the laboratory and final presentation. They enjoyed the interactive aspect of the laboratory as a game and how well it tied into the material and skills learned in lecture and laboratory. The most convenient part for the instructor is how easily this method can be incorporated into an existing laboratory syllabus. Any laboratory has the potential to be gamified because this method only changes intrinsic motivations and not the materials and skills required.

SUPPLEMENTAL MATERIALS

- Appendix 1: Assignment overview
- Appendix 2: Example laboratory exercise
- Appendix 3: Backstory of the Micropocalypse
- Appendix 4: Final presentation rubric

ACKNOWLEDGMENTS

The author gratefully acknowledges Craig Byron, Katharine Northcutt, and Virginia Young for their feedback and suggestions on the manuscript and appendices. The author declares that there are no conflicts of interest.

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